Radial nerve disruption following application of a hinged elbow external fixator: a report of three cases

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Radial Nerve Disruption Following Application of a Hinged Elbow External Fixator

A Report of Three Cases

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A hinged or articulated elbow external fixator is recommended for patients with elbow instability[1], as a protective device following extensive capsular release of elbow contractures[2], after ligamentous reconstruction[3], for distraction interposition arthroplasty[4], and in the management of complex elbow fracture-dislocations[5]. The hinged external fixator permits early postoperative elbow mobilization while maintaining elbow stability. There is a growing recognition of the value of and indications for articulated external fixation of the elbow[6], despite the possibility of serious complications. Cheung et al.[6] classified complications related to hinged external fixators of the elbow as major and minor. Minor complications, which occurred in 15% of patients, included local erythema and nonpurulent pin-site drainage lasting longer than five days and the need for skin release to decrease tension adjacent to the pins. Major complications, which occurred in 10% of patients, included purulent pin-site drainage, fixator malalignment, pin loosening, and deep infection. Although cases of transient radial nerve palsy are described in the literature[1,7], to the best of our knowledge no permanent radial nerve palsy has been documented following application of a hinged external fixator. We present three cases of radial nerve palsy due to complete nerve disruption after application of a hinged external fixator for the treatment of complex elbow injuries.

The patients were informed that data concerning their cases would be submitted for publication, and they consented.

Case Reports

Case 1. A forty-seven-year-old male gardener fell on the right, dominant arm. No fracture or dislocation was noted. Seven years later, ulnar nerve decompression with a medial epicondylectomy was performed elsewhere (i.e., not at our hospital) to treat posttraumatic irritation of the ulnar nerve. Because the symptoms persisted postoperatively, the patient was seen by an elbow specialist at another institution and was diagnosed with marked medial and lateral elbow instability. Reconstruction of the medial and lateral ligaments was performed with use of semitendinosus tendon autografts, the ulnar nerve was transposed anteriorly (subcutaneously), and the elbow was stabilized by placing a hinged external fixator (Dynamic Joint Distractor II [DJD II]; Stryker Trauma, Selzach, Switzerland). The pins were placed percutaneously. Complete radial nerve palsy was noted immediately postoperatively. The external fixator was removed four weeks later. Clinically and electrophysiologically, the level of injury was localized near the division of the sensory and posterior interosseous nerves in the area of the distal humeral pin. Twelve months postoperatively, there were no detectible sensory radial nerve action potentials. The extensor carpi radialis, extensor digitorum communis, and abductor pollicis longus muscles had high spontaneous activity but no voluntary activity, findings that were highly suspicious for a complete lesion of the common radial nerve.

The patient was referred to our institution for an eventual radial nerve reconstruction with or without tendon transfer, but he refused any further surgical treatment.

Case 2. A seventy-four-year-old man fell on the left, nondominant arm and sustained a simple posterior elbow dislocation (without a fracture). After closed reduction at another hospital (i.e., not ours), the elbow remained unstable without any neurological deficit. Because the patient had persistent instability, open repair of the radial and ulnar collateral ligaments was performed, but the elbow remained unstable. A hinged external fixator (DJD II) was applied. The humeral half-pins (3 mm, threaded) were placed percutaneously in the manner proposed by the manufacturer[8], through a small incision, tunneling until bone contact was made, and hand drilling of the pin.

Postoperatively, complete radial nerve palsy was observed, and one day later surgical exploration revealed a complete disruption of the radial nerve, with loss of substance of >4 cm at the level of the distal humeral pin, although this was not treated at that time. The external fixator was removed four weeks later, and the patient was referred to our institution because of persisting elbow instability and total loss of radial nerve function. The elbow had complex medial-lateral instability with anterior radial head dislocation in flexion and pronation. Initially, reconstruction of the

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Fig. 1-A

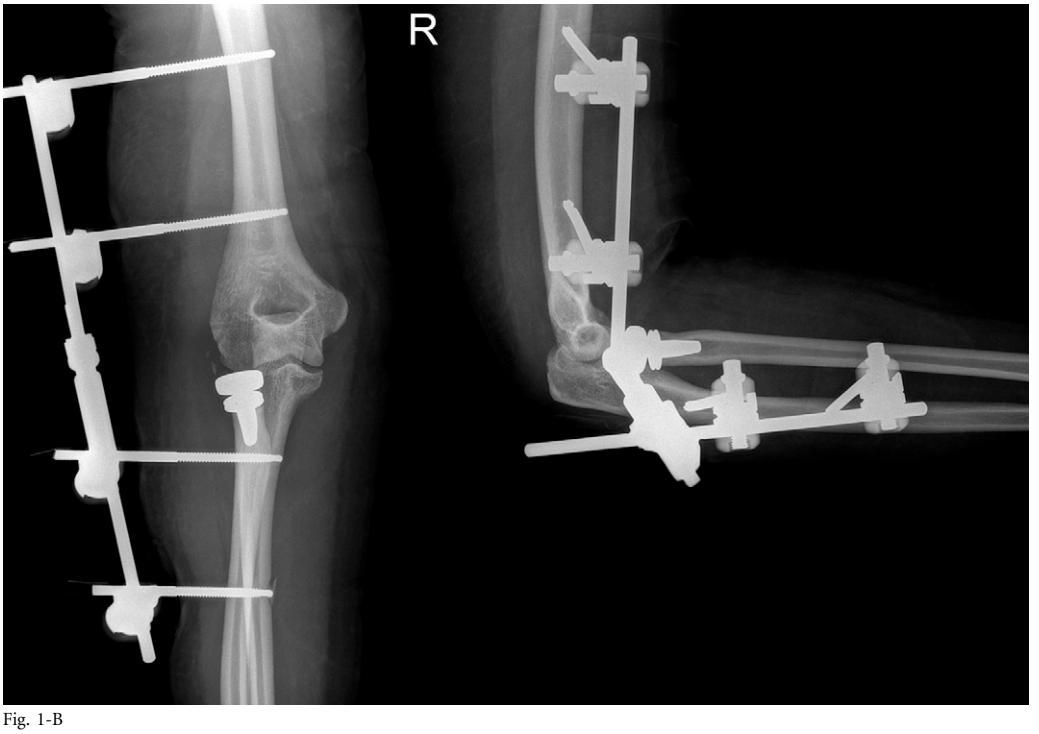

Fig. 1-B

Figs. 1-A, 1-B, and 1-C Case 3. **Fig. 1-A** Complex posterior elbow dislocation with a radial head fracture. **Fig. 1-B** Postoperative anteroposterior and lateral radiographs. The elbow joint is reduced with the hinged external fixator and the radial head prosthesis in place. The distal humeral half-pin is 38 mm from the lateral epicondyle and the proximal pin is 99 mm from the lateral epicondyle.

anular ligament as well as the medial and lateral collateral ligaments was performed with use of autologous toe extensor tendon grafts. Five weeks postoperatively, after the patient had regained satisfactory stability and elbow mobility, tendon transfers for wrist, finger, and thumb extension were performed. The patient refused radial nerve reconstruction. Three months

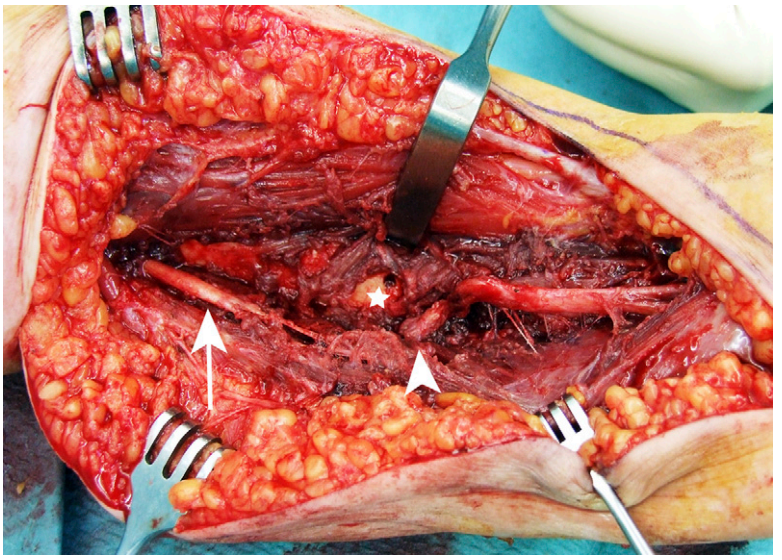

Fig. 1-C

Disruption of the radial nerve and its relationship to the distal humeral pinhole. The arrow indicates the proximal radial nerve stump, the arrowhead indicates the distal radial nerve stump, and the star indicates the pinhole.

postoperatively, he had free and stable elbow motion with 145° of flexion, a 10° loss of extension, and 30° of active wrist extension.

CASE 3. A fifty-five-year-old female architect fell while skiing and sustained a complex posterior dislocation of the right, dominant elbow with a comminuted radial head fracture (Fig. 1-A). Closed reduction and application of a long arm cast was performed at a local hospital. Immediately after reduction, redislocation of the elbow in the cast was noted, and the patient was referred to a trauma center, where two additional unsuccessful attempts at closed reduction and cast immobilization were carried out. Six weeks after the injury, she had a persistent dislocation. A closed reduction was not possible. Open reduction was done through a posterior approach. The medial and lateral collateral ligaments were reattached, and a radial head prosthesis was inserted. Because of the long-standing preoperative dislocation and incomplete restoration of stability intraoperatively following ligament repair, a hinged external fixator (DJD II) was applied (Fig. 1-B). As the fixator pins (3-mm half-pins) could not be placed through the posterior incision, they were placed percutaneously.

Immediately postoperatively, a complete radial nerve palsy was noted, and electrodiagnostic testing four weeks after the surgery raised a high suspicion for a severe nerve injury. The radial nerve was explored during the removal of the external fixator five weeks postoperatively. A complete disruption of the nerve was found at the level of the distal humeral pin (Fig. 1-C). We performed secondary reconstruction three months later to avoid potential contamination from the fixator pins and to avoid risking the elbow stiffness that can result from the elbow immobilization that is necessary following nerve reconstruction and tendon transfer. Three months postoperatively, the elbow was stable with a 100° arc of elbow motion and nearly full forearm rotation. The 2 to 3-cm gap within the radial nerve was reconstructed by the interposition of four strands of sural nerve graft. At the same time, a pronator teres tendon transfer for wrist extension was accomplished. Three months after the nerve reconstruction and tendon transfer, the patient had 40° of active wrist extension and 10 kg of grip strength but no active thumb or finger extension.

Discussion

We report on three patients who were treated with a hinged external fixator (the Dynamic Joint Distractor II [DJD II]) for elbow instability and subsequently had complete loss of radial nerve function at the site of the distal humeral pin. In all three cases, the pins were applied percutaneously according to the instructions in the manufacturer's brochure—i.e., after a small skin incision was made, the pins were inserted percutaneously with use of the appropriate pin sleeves[8]. Nevertheless, there was complete radial nerve paralysis in all cases, with a documented segmental nerve defect in two of the three cases. Two cases of transient common radial nerve palsy[1,7] and two cases of temporary posterior interosseous nerve palsy have been reported[9,10] previously. McKee et al.[1] reported on sixteen patients treated with a hinged external fixator (the Compass elbow hinge, a circular hinged device manufactured by Smith & Nephew Richards, Memphis, Tennessee) because of recurrent complex elbow instability; the authors stated that one patient had a temporary radial nerve palsy but did not provide any additional details[1]. Stavlas et al.[7] used the Orthofix system (Orthofix Srl, Verona, Italy) for dynamic external fixation of the elbow in eight patients with complex elbow injuries and reported one complete radial nerve palsy with later spontaneous recovery. Fox et al.[9] treated eleven patients with the Compass elbow hinge; one had a posterior interosseous nerve lesion with complete spontaneous recovery. Tomaino et al.[10] also described a posterior interosseous nerve palsy, which resolved after 5.5 months.

In 2008, Cheung et al.[6] reported 100 consecutive cases in which a hinged external fixator of the elbow had been applied between 1998 and 2005. The pins were typically placed percutaneously by incision of the skin, performance of blunt dissection to the bone, and placement of a drill sleeve while predrilling and inserting the pins. No nerve injuries were observed. The authors believed that two reasons may have explained this favorable outcome: the operations were performed by experienced elbow surgeons and, in many instances, the pins were placed under direct visualization.

The course of the radial nerve around the distal part of the humerus is complex, and the radial nerve is at risk for injury during an operative procedure in this area. The radial nerve spirals obliquely across the back of the humerus, where it lies posterior to the uppermost fibers of the medial head of the triceps muscle, which separate the radial nerve from the humerus in the first part of the spiral groove. On reaching the lateral side of the humerus, it pierces the lateral intermuscular septum to enter the anterior compartment and then descends deep in a furrow between the brachialis and proximal brachioradialis muscles[11]. In an anatomic study, Kamineni et al.[12] found that the radial nerve crossed the humerus, from posterior to anterior, at an average of 102 ± 10 mm from the lateral epicondyle. They tried to define an absolute safe zone for pin entry in the lateral aspect of the distal part of the humerus and measured the transepicondylar distance on radiographs; they projected this distance on the lateral aspect of the humerus from the lateral epicondyle to proximally. The absolute safe zone was suggested to be within the distal 70% of this distance. In another anatomical study, Gausepohl et al.[13] stated that implantation of screws in the distal part of the humerus as near as 6 cm proximal to the lateral epicondyle was possible and safe. Clement et al.[11] evaluated forty lateral humeral half-pins that had been inserted in twenty cadavers 3 cm (the distal pin) and 5 cm (the proximal pin) proximal to the elbow joint line through a 1-cm skin incision. The entry point was located with the aid of an image intensifier. Dissection of the upper limbs revealed direct nerve injury caused by the distal humeral pin in three cases and direct nerve injury by the proximal humeral pin in one. In nine specimens, the pins were in direct contact with the radial nerve. Even though twenty-seven pins had no contact with the nerve, these authors concluded that humeral pins should be placed in an open manner only[11]. In our patients, the distal humeral pin was placed under fluoroscopic control referenced to the lateral epicondyle. Retrospectively, the distance between the pin and the lateral epicondyle was determined to be 32 mm in Case 1, 47 mm in Case 2, and 38 mm in Case 3. None of the pins were placed further proximally.

Application of a hinged elbow external fixator is generally viewed as a challenging procedure. Despite the well-known risk of damaging the radial nerve during the placement of the humeral pins[14] and the anatomically proven high risk of injuring the nerve by placing the pins percutaneously[11], we were unable to find a previous report of a complete and permanent radial nerve palsy after percutaneous or open application of a hinged external elbow fixator. In the present report, we presented three cases of complete radial nerve disruption due to percutaneous placement of the humeral pins. The fact that three major nerve complications occurred within one year and that all three patients had been operated on by experienced elbow surgeons suggests that this devastating complication is probably underestimated and underreported. The results of the current cases lend clinical support for the findings in the anatomic study by Clement et al.[11]. We therefore also highly recommend placing these pins through an open approach spreading bluntly down to bone and inserting the pins under direct visualization. ■

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